

# Significance of the position of the proximal tip of the tibial nail: An important factor related to anterior knee pain

Mohammad Ali Tahririan, Ehsan Ziaei<sup>1</sup>, Reza Osanloo<sup>1</sup>

Departments of Orthopaedics, Kashani Hospital, <sup>1</sup>Student Research Committee, Isfahan University of Medical Sciences, Isfahan, Iran

## Abstract

**Background:** Intramedullary nailing is the treatment of choice for the majority of tibial shaft fractures and anterior knee pain is the most common complication of this surgery; however, its etiology is still unknown. The purpose of this study was to assess the predicting factors related to anterior knee pain following tibial nailing.

**Materials and Methods:** Patients with isolated, unilateral tibial shaft fracture who had undergone tibial nailing were identified retrospectively. Data including age, sex, type of fracture, technique of surgery and location of the nail were collected and finally the association between the above variables and knee pain were analyzed via SPSS software.

**Results:** A total of 95 patients participated in the study. The mean age of the participants was  $33.52 \pm 1.62$ , 87 (91.6%) of whom were male and 74 (77.9%) had close fractures respectively. The method of surgery in 60 (63.2%) patients was paratendinous approach and in 35 (36.8%) was transtendinous. Twenty six (27.4%) of the patients had anterior knee pain. There were no significant differences between the two groups of patients with and without knee pain by age, sex, type of fracture and type of surgery ( $P = 0.952, 0.502, 0.212$  and  $0.745$ , respectively). Patients with protrusion of the nail from the anterior cortex had higher risk of developing knee pain after surgery (odds ratio: 2.76, confidence interval: 1.08, 7.08,  $P = 0.031$ ).

**Conclusion:** The results revealed a higher risk of developing anterior knee pain after tibial nailing in patients with protrusion of the nail from the anterior cortex.

**Key Words:** Anterior knee pain, fracture, nailing, surgery, tibia

## Address for correspondence:

Dr. Mohammad Ali Tahririan, Department of Orthopaedics, Kashani Hospital, Isfahan University of Medical Sciences, Isfahan, Iran.

E-mail: tahririan@med.mui.ac.ir

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## INTRODUCTION

Intramedullary nailing is the treatment of choice for the majority of tibial shaft fractures with low rate

of complications such as non-union, malunion, joint stiffness and infection.<sup>[1-3]</sup> One of the most common complications of the tibial nailing is chronic anterior knee pain whose incidence has been reported to range from 10% to 86% respectively.<sup>[2,4,5]</sup> Until date, the etiology of anterior knee pain after intramedullary nailing of tibia is still unknown. Several studies have proposed that a patellar splitting approach for nail insertion is associated with a higher prevalence of anterior knee pain than a medial paratendinous approach.<sup>[6-11]</sup> Some other studies have reported technical causes for the chronic anterior knee pain such as nail or screw prominence, traumatization of the

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fat pad or patellar tendon, iatrogenic intra-articular damage and neuroma of the infra-patellar branch of the saphenous nerve.<sup>[4,12-15]</sup> Moreover, some investigators have blamed post-operative muscle weakness and younger age as other important factors for the post-operative anterior knee pain.<sup>[16]</sup>

The purpose of this study was to assess demographic issues (such as age, gender), type of the fracture, surgical technique and position of the proximal tip of the nail related to anterior knee pain following tibial nailing.

## MATERIALS AND METHODS

All patients with isolated, unilateral, closed or open (Gustilo type I, II, IIIA) tibial shaft fracture who were referred to Kashani University Hospital (Isfahan, Iran) from July 2009 to July 2011 had undergone tibial nailing were identified retrospectively to conduct a cross-sectional study. Patients with the following criteria were included in to the study; 15 years of age or older; extra-articular fracture; absence of any major comorbidities; absence of Gustilo type IIIB and IIIC open fractures. Patients with anesthesia and neuroma around the incision site, superficial or deep infection in the recovery period, nonunion or angular malunion, weakness of quadriceps and hamstring muscles, previous injury to both knees and secondary trauma were excluded from the study.

All the selected patients were called for review and the purpose of the study was explained for them. Demographic data including age, sex and also information about the fracture (open or close fracture), surgery, recovery and post recovery periods were obtained from the medical documents of the patients. Two types of surgery were used: Closed nailing with the use of a patellar tendon-splitting (transtendinous) and closed nailing with the use of a paratendinous approach. In all the patients operations were done within 48 h after injury by trauma surgeons who were expert with these techniques. Intramedullary nailing technique was completed with 2 medial to lateral proximal and 2 medial to lateral distal locking screws and union of the fracture sites were completed. In all the patients the same type of nail were used.

The patients were examined for anterior knee pain, anesthesia and neuroma around the incision site and also, lateral radiographs of both knees were taken. Anterior knee pain was evaluated during rest, walking, running, squatting and kneeling. All the patients were independently examined by two orthopedic experts.

In all the patients, distances from the nail to the tibia plateau and anterior tibial cortex were evaluated in the lateral X-rays according to the definition of Keating *et al.*<sup>[7]</sup> On the lateral X-ray, the distance between the two parallel lines, one passing through the tibial plateau and the other through the apex of the nail was defined as the height of the nail. The negative (–) symbol was used to indicate that the nail was below the articular surface and positive (+) to show the extent of nail above the articular surface of tibial plateau. On the same lateral X-ray, anterior cortex-nail distance was defined as the distance between the lines drawn on the anterior cortex of the tibia and the anterior tip of the nail. The positive (+) value was assigned if the nail protruded beyond the cortex and the negative (–) value was assigned if it was deep in the cortex.

## Ethics

The study was approved by the ethical committee of Isfahan University of Medical Sciences, Isfahan, Iran.

## Statistical data analysis

The analysis of data was performed using the SPSS for Windows software (version 16.0; SPSS Inc., Chicago, Illinois). Student's *t*-test and Chi-squared tests were used to assess statistical significance which was assumed to be at the level of  $P < 0.05$ . The data were estimated by the odds ratio (OR) in univariate analysis and also multiple logistic regressions to estimate adjusted OR and 95% confidence intervals (CI). Data were given as number (percent) or mean  $\pm$  standard error.

## RESULTS

According to the medical documents, a total number of 102 patients met our inclusion and exclusion criteria. Seven of them had left the city and were not able to follow-up. Of the 102 patients, 95 were the final population of the study. The mean age of the patients was  $33.52 \pm 1.62$ , from among whom 87 (91.6%) were male, 74 (77.9%) had close fracture and 60 (63.2%) had undergone paratendinous method of surgery respectively.

Twenty six (27.4%) of the patients had anterior knee pain. The pain was exacerbated by kneeling in 60% of the participants. Table 1 illustrates the association of knee pain with age, sex, type of fracture (close vs. open) and method of surgery (transtendinous vs. paratendinous). The mean age of the group with knee pain was  $32.69 \pm 2.78$  and  $33.84 \pm 1.98$  in the group without pain, the difference of which was not statistically significant ( $P = 0.754$ ). We also classified the patients into two groups of older than 33.5

and <33.5 years of age, as the mean age of patients was  $33.52 \pm 1.62$ . As you can be seen in Table 1, there was no significant difference between the two age classified groups in the presence of knee pain ( $P = 0.952$ ). Furthermore, there were no statistically significant differences between the two groups of patients with and without anterior knee pain by sex, type of fracture and type of surgery ( $P = 0.502, 0.212$  and  $0.745$ , respectively).

We also defined the place where the tip of the nail was located. As described above we classified them into groups of positive and negative. As shown in Table 2, patients with positive location of the nail from the anterior cortex had a higher risk of developing knee pain after surgery (OR: 2.76, CI: 1.08, 7.08,  $P = 0.031$ ). Risk of developing knee pain was the same in patients with positive or negative location of nail from superior cortex (OR: 2.25, CI: 0.84, 5.96,  $P = 0.099$ ). After adjusting for age, sex, type of surgery and fracture, no significant changes were witnessed.

**Table 1: Association of age, sex, type of fracture and method of surgery with anterior knee pain in patients with tibial nailing surgery**

Variables	Anterior knee pain (%)		OR (95% CI)	Adjusted OR (95% CI)
	Yes <sup>†</sup> (n=26)	No (n=69)		
Age (years)				
Less than 33.5 <sup>†</sup>	16 (27.6)	42 (72.4)	1.02	0.86
More than 33.5	10 (27.0)	27 (73.3)	(0.40, 2.59)	(0.32, 2.32)
Sex				
Male <sup>†</sup>	23 (26.4)	64 (73.6)	0.59	0.52
Female	3 (37.5)	5 (72.5)	(0.13, 2.70)	(0.11, 2.49)
Type of fracture				
Open <sup>†</sup>	8 (38.1)	13 (61.9)	1.91	2.27
Close	18 (24.3)	56 (75.7)	(0.68, 5.35)	(0.78, 6.59)
Method of surgery				
Transtendinous <sup>†</sup>	10 (28.6)	25 (71.4)	1.17	1.17
Paratendinous	15 (25.0)	45 (75.0)	(0.44, 3.08)	(0.43, 3.16)

Data are given as number (%). OR: Odds ratio, CI: Confidence interval, n: Number,

<sup>†</sup>Means the reference group

**Table 2: Association between the anterior knee pain and the place that tip of the nail is located**

Variables	Anterior knee pain (%)		OR (95% CI)
	Yes <sup>†</sup> (n=26)	No (n=69)	
Space from the anterior cortex			
Positive <sup>†</sup>	17 (37.8)	28 (62.2)	2.76* (1.08, 7.08)
Negative	9 (18.0)	41 (82)	
Space from the superior cortex			
Positive <sup>†</sup>	10 (40.0)	15 (60.0)	2.25 (0.84, 5.96)
Negative	16 (22.9)	54 (77.1)	

Data are given as number (%). OR: Odds ratio, CI: Confidence interval, n: Number,

\*Means  $P < 0.05$ , <sup>†</sup>Means the reference group

## DISCUSSION

In this study demographic issue, type of the fracture, surgical technique and position of the proximal tip of the nail related to anterior knee pain following tibial nailing has been assessed.

According to the results, 27.4% of the patients developed anterior knee pain after tibial nailing. In 60% of whom, the pain was exacerbated by kneeling. According to the results, the knee pain was not associated with sex and/or age. Furthermore, no significant relation was found between type of fracture (close vs. open) and type of surgery (transtendinous vs. paratendinous). Although the mean incidence of knee pain has been reported as 47.4% in a review conducted by Katsoulis *et al.*, the range was between 10% and 86% respectively. They have reported that anterior knee pain is more frequently related to transtendinous approach and that patients have affected kneeling recreational activities.<sup>[4,17]</sup> A study conducted by Keating *et al.* revealed that 57% of patients developed anterior knee pain, 83% of which were exacerbated by kneeling. In contrast to our results, Keating *et al.* have reported that transtendinous method is associated with a higher incidence of knee pain,<sup>[7]</sup> this might be because they didn't consider the the nail protrusion. Cartwright-Terry *et al.* has shown that 83% of patients developed anterior knee pain after tibial nailing. Their study revealed that those who were manual workers developed more knee pain after tibial nailing. Hence, it is in order to speculate that a weak point of our study is lack of information about the occupation and life style of the participants.<sup>[1]</sup> In contrast to Cartwright-Terry *et al.* study and also our study that found no relation between age and knee pain, Court-Brown *et al.* in their study have reported that patients with knee pain after tibial nailing were significantly younger.<sup>[18]</sup> We found no association between gender and knee pain. However Kim *et al.* have reported that knee pain after tibial nailing was more common among women, however, similar to our results, they found no relation between age and type of fracture and knee pain.<sup>[19]</sup> In another study, Väistö *et al.* in which they compared two different nail-insertion techniques (transtendinous and paratendinous), their results are in line with our results which show that there is no significant differences between the two types of surgery in developing anterior knee pain after tibial nailing.<sup>[20]</sup> Yu *et al.* have reported transtendinous method as a risk factor which should be avoided. Lee *et al.* have also reported similar results.<sup>[21,22]</sup> Väistö *et al.* conducted an ultrasound study of patellar tendon after tibial nailing to compare the changes between patients with and without anterior knee pain. They have reported that the two different approaches (transtendinous and paratendinous) don't make any difference.<sup>[23]</sup>

We classified our patients according to the location of tip of the nail. Our results showed that protrusion of the nail beyond the anterior cortex (positive category as described above) was associated with higher risk of anterior knee pain. The analysis of superior cortex revealed that there was no association between the amount of nail above or below the articular surface of tibial plateau and anterior knee pain. Keating *et al.* and also Uzümcügil *et al.* have reported that their results showed no relationship between nail protrusion and nail distance from the cortex and knee pain.<sup>[7,24]</sup> However, the study conducted by Yu *et al.* confirms our results, where they have reported that nail protrusion is a risk factor of knee pain after tibial nailing.<sup>[21]</sup>

The retrospective study design and the relative small number of patients were limitations of this study and not all potential predictors of anterior knee pain following tibial nailing, including alcohol consumption, corticosteroid use and obesity, were investigated. Use of qualitative variables instead of quantitative variables with regard to position of tip the nail related to the anterior and superior cortex was the other weak point of the study.

In conclusion, our results revealed a higher risk of developing anterior knee pain after tibial nailing in patients with protrusion of the nail from the anterior cortex. No relation was found between knee pain and age, sex, type of fracture, method of surgery and superior cortex nail protrusion. Hence we suggest that nail protrusion should be avoided in tibial nailing procedure in order to have lower prevalence of knee pain after the surgery.

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